Freshwater Quality Monitoring Protocol
San Francisco Area Network

Standard Operating Procedure (SOP) # 4

QUALITY ASSURANCE PROJECT PLAN (QAPP)

Version 2.01

August 2005

Revision History Log:

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1.0	February 16, 2005	Mary Cooprider	Table 10, few minor edits	Clarification of QA/QC measures	1.01
1.01	May 12, 2005	Mary Cooprider	Update tables and schedule	Preparation for technical peer review	2.0
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Section A1. Title and Approval Sheet; Citation for QAPP; Preface/Acknowledgements

Program Title	U.S. Department of Interior, National Park Service, Inventory and Monitoring Program, Water Quality Monitoring
Lead Organization	National Park Service, San Francisco Bay Area Network, Water Quality Monitoring Program
Primary Contact	Mary Cooprider, Water Quality Specialist, (415) 464-5122
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QAPP Preface and Acknowledgements

The preparation of this Quality Assurance Project Plan (QAPP) was funded by the National Park Service Water Resources Division. This QAPP is adapted from the Quality Assurance Management Plan (QAMP) for the San Francisco Bay Regional Water Quality Control Boards' Surface Water Ambient Monitoring Program (SWAMP) (Puckett, 2002). The content of the SWAMP QAMP is used frequently here. This QAPP follows the formatting and guidelines set forth by the California Department of Water Resources' *Guidelines for Preparing Quality Assurance Project Plans* (California Department of Water Resources, 1998). In addition, Golden Gate National Recreation Area's Crissy Field Restoration Program QAPP (Ward, 2004) was closely followed. In order to insure the highest level of data comparability within NPS park units, this QAPP mirrors the Crissy Field QAPP where applicable.

Approvals:

Mary Cooprider, SFAN Water Quality Specialist, Water Quality Monitoring Program

____ Date ________________

SFAN Network Coordinator, Inventory and Monitoring Program

____ Date ________________

Brannon Ketcham, Hydrologist Point Reyes National Seashore

____ Date ________________

Tamara Williams, Hydrologist, Golden Gate National Recreation Area

____ Date ________________

Roy Irwin, Water Quality Section, Water Resources Division, National Park Service

____ Date ________________

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PROJECT MANAGEMENT

Section A3. Distribution List and Contact Information

Table 1. QAPP Distribution List

Name	Agency/Affiliation
Water Quality Specialist	San Francisco Area Network
Brannon Ketcham, Hydrologist	Point Reyes National Seashore
Tamara Williams, Hydrologist	Golden Gate National Recreation Area
Darren Fong, Aquatic Ecologist	Golden Gate National Recreation Area
Marcus Koenen, I&M Coordinator	San Francisco Area Network
Tom Leatherman, Chief Natural Resources	Pinnacles National Monument

Section A4. Project/Task Organization

This plan is intended to be a long-term (30+ years) monitoring plan. However, tasks and budget will be organized in five year increments. The plan will be managed and largely implemented by network (SFAN) personnel with assistance from park staff, and technical expertise from the NPS Water Resources Division (WRD) and local experts where necessary. Decisions regarding the I&M Water Quality Program development and long-term monitoring plan have been and will continue to be informally made by consensus of the SFAN Aquatic Professionals group. The I&M Water Quality Program will remain adaptive to changing park and network needs. This group consists of key network staff including the water quality specialist, network coordinator, park hydrologists and an aquatic ecologist. Broader-based, long-term decisions are approved by the NPS-WRD. These include approval of WRD-funded staff workplans and approval of the overall monitoring plan.

Table 2. Project Tasks and Responsibilities

Name	Title/Responsibility
Water Quality Specialist (SFAN)	Technical Lead, oversee collection of monitoring data and data management, coordinate report writing and protocol staff revision
Marie Denn, Aquatic Ecologist (PWR) Darren Fong, Aquatic Ecologist (GOGA) Brannon Ketcham, Hydrologist PORE) Tamara Williams, Hydrologist GOGA)	Aquatic Professionals Team, technical
Marcus Koenen, SFAN I&M Coordinator	Coordinate with water quality specialist reporting requirements, assist with peer review process
Dave Press, SFAN Data Management Lead	Assist with water quality data collection and validation; database uploading to WRD

Section A5. Problem Definition/Background

"National Park managers are directed by federal law and NPS policies and guidance to know the status and trends in the condition of natural resources under their stewardship to fulfill the NPS mission of conserving parks unimpaired" (Welch, 2003). The mission of the National Park Service is:

> "*...to promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purposes of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations* (National Park Service Organic Act 1916)."

"Recognizing the need to understand the condition of natural resources within the park system, a servicewide inventory and monitoring (I&M) program was established (NPS-75 1995; http://science.nature.nps.gov/im/monitor/nps75.pdf). The I&M program was given the responsibility to determine the nature and status of natural resources under NPS stewardship and to monitor changes in the condition of these resources over time. Information from inventory and monitoring efforts can then be incorporated into NPS planning, management, and decision making" (Welch, 2003).

In addition to the overarching NPS goal of resource stewardship, other policies and guidance are aimed specifically at maintaining or improving water quality. California's Porter-Cologne Water Quality Control Act and the federal Clean Water Act (CWA) direct water quality programs to implement protection and restoration of the integrity of State waters. Section 303d of the Clean Water Act lists all impaired waters. These are waters with compromised quality and/or limited use due to an excess of one or more pollutants. Related to this, the overarching Government Performance and Results Act (GPRA) goal for water quality is that "…99.3% of streams and rivers managed by NPS will meet State and Federal water quality standards". Impaired water bodies in SFAN are listed in Table 3. Primary SFAN water quality issues include agricultural operations (dairy and beef cattle ranching, vegetable farming, viticulture, mariculture), recreational use (beaches, stable operations, dog walks), erosion and sedimentation, and water supply (flooding, overwithdrawal).

Table 3. Impaired water bodies in the SFAN

Water body	Park Unit	Pollutant
Coyote Creek	GOGA	Diazinon
Lagunitas Creek	PORE, GOGA	Pathogens, Sediment, Nutrients
Richardson Bay	GOGA	High Coliform, Mercury, PCBs, Pesticides, Exotic Species
San Francisco Bay	GOGA, PRES	Mercury, PCBs, Nickel, Pesticides, Exotic Species, Dioxin, Selenium
San Francisco Bay Urban Creeks	GOGA, PRES, JOMU	Diazinon
San Francisquito Creek	GOGA	Diazinon, Sediment
San Pedro Creek	GOGA	High Coliform
Tomales Bay	PORE, GOGA	Pathogens, Sediment, Nutrients, Mercury

The primary objectives of this monitoring program are to 1) Maintain waters that vary within their natural chemical and biological ranges and meet applicable federal and state water quality criteria, 2) Improve the water quality of impaired waters, and 3) Maintain high water quality where it exists.

Based on these objectives, monitoring data from this program will be used to answer the following questions:

- What are the natural chemical and biological ranges in water quality within the freshwaters of SFAN?
- What are the long-term trends in water quality in SFAN water bodies?
- Is the water quality of SFAN water bodies in compliance with designated beneficial uses?
- What are the point and non-point pollution sources within the watersheds?
- Are specific management actions reducing pollution loads?

Section A6. Project/Task Description

Quality Assurance

The SFAN Water Quality Monitoring Program has been developed and will be implemented with the objective of collecting high quality monitoring data that could be of the most use to the National Park Service, U.S. Geological Survey, and California and San Francisco Bay Area monitoring programs. A technical panel of aquatic resource specialists will be consulted regarding QA/QC measures and plan implementation.

Data Management, Data Evaluation, and Reporting

Data management, evaluation, and reporting will be high priorities of SFAN. The NPSTORET database will be the central depository of all data collected by SFAN. The SFAN version of NPSTORET will be sent annually to the WRD. It is the goal of the SFAN data management program to ultimately provide standardized data management, evaluation, and reporting. It is also a goal of SFAN to be as "paperless" as possible, and to develop a database that will allow internet web access to all parties interested in the data and technical reports produced through SFAN studies. SFAN will include the use of existing data to the extent that it can be verified and placed or linked into centralized locations, but such "outside data" shall not be a part of the official SFAN database at this time. A summary of the NPSTORET data base is included in the protocol narrative of the overall water quality monitoring plan.

Table 4. Project Task Extended Timetable

Deliverables	FY05	FY06	FY07	FY08	FY09
Develop QAPP	X				
Meet with local technical experts to review monitoring protocol	X				
Finalize protocol and have peer reviewed	X				
Conduct equipment inventory and calibration, purchase any needed equipment	X	X			
Collect monitoring data		X	X	X	X
Produce annual summary report		X	X	X	X
Share results with parks and scientific community at annual “Water Quality Forum”		X	X	X	X
Produce comprehensive data analysis and synthesis (trends) report					X

Table 5. Overall Water Quality Monitoring Schedule

Stream	Park Unit	FY06	FY07	FY08	FY09
Olema Creek	PORE	M, S, W	M, S, W	M,S, W	M,S,W
Lagunitas Creek	PORE/GOGA			M	M
Pine Gulch	PORE	M	M		
Lower Redwood Creek	GOGA/MUWO			M ,S	M, S
Upper Redwood Creek	GOGA/MUWO			M	M
Rodeo Creek	GOGA	M, S	M, S		
Tennessee Creek	GOGA	M, S	M, S		
Nyhan Creek	GOGA	M, S	M, S		
Oakwood Creek	GOGA	M, S	M, S		
West Union Creek	GOGA			M	M
Franklin Creek	JOMU	M	M		
Strentzel Creek	JOMU	S	S		
Chalone Creek	PINN	M, S	M, S		

M monthly monitoring (winter and spring only for Chalone Creek and West Union Creek)
S monitoring during at least one storm event
W weekly monitoring for five consecutive weeks in winter and summer

Section A7. Data Quality Objectives (DQOs) and Criteria for Measurement Data

DQO's are qualitative and quantitative statements of the quality of data neded to support specific decisions or actions. Data acceptability criteria are included in DQOs. The purpose of DQOs is to document 1) the intended use of the data in order or importance, 2) decision to be made when data are obtained, and 3) decision makers who will use the data (California Department of Water Resources, 1998). Decision makers for SFAN will generally be the same for each parameter. Recommendations will be developed by network staff and park aquatic professionals. These recommendations in the form of annual reports or summaries will be made to managers such as Resource Management Chief's and Park Superintendents. Other decision makers may include local agencies and landowners. All data including core parameters, bacteria, nutrients, and sediment have the same intended uses since they all help identify pollution sources and areas of concern with respect to aquatic health and other beneficial uses.

Table 6. Data utilization and Related Management Decisions

Parameter	Intended use of data	Relevant Management Decision
Core parameters	Determine the natural variation and range in water quality parameters. Analyze data from control sites or reference streams; analyze annual, seasonal, and daily data for each station and each group of stations in a stream or watershed	If results are unexpected (i.e., out of normal range), choose different reference, or "control" sites or pursue geological and other studies that would help explain the variability
Core parameters	Determine the long-term trends in water quality parameters. Analyze data from all sites. Analyze annual and seasonal data for each station and for each group of stations in a stream or watershed.	If data trends point to problems (e.g., consistent decline in D.O., or consistent increase or decline in pH or temperature) check data with surrounding areas, compare with local and regional climate data, compare data with other indicators (e.g., air quality)
Core parameters, nutrients, bacteria, sediment	Determine if water bodies are meeting water quality criteria. Determine the level of compliance with beneficial uses. Focus on sites known to be impaired; analyze data for each site for each group of stations (collectively) in a stream.	Determine what level of compliance is acceptable (e.g., 100% of stations meeting the criteria 90% of the time); adapt monitoring strategy if necessary to focus on stations that do not meet criteria
Core parameters, nutrients, bacteria, sediment	Determine the sources of water quality degradation within park watersheds. Compare data from individual sites from one sampling event to another; also compare data from multiple sites within a stream. Provide data to local agencies (where appropriate and not for regulatory purposes) and landowners	Make decision on how to present data and work internally with other park divisions where applicable, with local landowners, and with agencies to alleviate problems; work with local groups on implementation strategies related to the BMPs
Core parameters, nutrients, bacteria, sediment	Determine if management actions are improving water quality. Compare data from individual sites from one sampling event to another; also compare data from multiple sites within a stream. Provide data to local agencies (where appropriate)	Continue management action if effective and use to encourage additional use of BMP; improve or change BMP,

Goals For Achieving Data Quality Objectives (DQO's)

Data quality objectives will be achieved in a number of ways including:

- Developing standard operating procedures (SOP) with standardized field and laboratory methods,
- Forming and convening a SFAN External Scientific Planning and Review Committee which will serve to bring together scientists that are "external" to the NPS as well as internal to provide on-going peer review of all SFAN water quality monitoring activities, with QA oversight being one of the primary focuses; and
- Documenting the comparability of laboratory and field methods that are consistent with the DQO's.

The intent is to provide the minimum standards and guidelines that SFAN should utilize, with strong encouragement to use more stringent criteria and to adopt methodologies that improve upon these minimum standards. A SOP aimed specifically at these modifications and improvements will be created (SOP 10: Methods for Protocol Revision). The major goal that this SFAN QAPP (SOP 4) can accomplish, is to have representative, comparable, accurate and precise data that can be shared statewide and nationwide, to the extent possible.

The following SOPs will be completed as part of the DQO process:

SOP 1: Revising the Protocol
SOP 2: Personnel Training and Safety
SOP 3: Equipment and Field Preparations
SOP 4: Quality Assurance Project Plan (QAPP)
SOP 5: Field Methods for Measurement of Core Parameters
SOP 6: Field Methods for Sampling Nutrients
SOP 7: Field and Methods for Sampling Bacteria
SOP 8: Field and Laboratory Methods for Sediment
SOP 9: Field Methods for Measuring Flow
SOP 10: Data Analysis
SOP 11: Data Reporting
SOP 12: Site Selection and Documentation

These SOPS are in Appendix H of the Freshwater Quality Protocol Narrative (“protocol narrative”). All SFAN SOPs will be completed over the next few months. The generally accepted goal at least for the first several years of the "start-up" of the SFAN Water Quality Monitoring Program is to ***"standardize where possible; document otherwise"***. The need for flexibility to accommodate park-specific sample collection needs was acknowledged, along with the need to standardize methods to the extent possible. Data quality will be attained by maximizing and documenting the accuracy and precision of the methods used. Any changes in procedures due to equipment changes or to improved precision and accuracy will be documented. Wherever possible, there should be overlap in sampling methods as well as overlap of staff when turnover occurs. Data quality objectives include representativeness, comparability, completeness, and precision. These are discussed further below (*from* Puckett, 2002):

Representativeness

The representativeness of the data is mainly dependent on the sampling locations and the sampling procedures adequately representing the true condition of the sample site. Requirements for selecting sample sites are discussed in more detail in the protocol narrative. Selection of appropriate sample sites and the use of only approved/documented analytical methods will insure that the measurement data does represent the conditions at the investigation site, to the extent possible. The goal for meeting total representation of the site will be tempered by the types and number of potential sampling points and media as well as the potential funding required for meeting complete representativeness.

Comparability

The comparability of data produced by SFAN is predetermined by the commitment of its staff and contracted laboratories to use standardized methods, where possible, including U.S. Environmental Protection Agency (EPA) approved analytical methods, or documented modifications that provide equal or better results. These methods have specified units in which the results are to be reported.

Completeness

The completeness of data is basically a relationship of how much of the data are available for use compared to the total potential data before any conclusion is reached. Ideally, 100% of the data should be available. However, the possibility of data becoming unavailable due to laboratory error, insufficient sample volume, or samples broken in shipping must be expected. Also, unexpected situations may arise where field conditions do not allow for 100% data completeness.

- Therefore, 90% data completeness is required for data usage in most cases.

Precision and Accuracy

The precision and accuracy of data are determined by particular actions of the analytical laboratory and field staff. The precision of data is a measure of the reproducibility of the measurement when an analysis is repeated. It is reported in Relative Percent Difference (RPD) or Relative Standard Deviation (RSD). The accuracy of an analysis is a measure of how much of the constituent actually present is determined. It is measured, where applicable, by adding a known amount of the constituent to a portion of the sample and determining how much of this spike is then measured. It is reported as Percent Recovery. The acceptable percent deviations and the acceptable percent recoveries are dependent on many factors including: analytical method used, laboratory used, media of sample, and constituent being measured.

It is the responsibility of the program manager (Water Quality Specialist) to verify that the data are representative while the analytical data's precision, accuracy, and comparability are mainly the responsibility of the laboratory. The program manager also has prime responsibility for determining that the 90% data completeness criteria are met or for justifying acceptance of a lesser percentage.

Laboratories performing the analysis of samples for this project have developed precision and accuracy limits for acceptability of data. For parameters and matrices which have EPA established criteria, the limits are either equal to, or more stringent than, the established limit.

Section A8. Special Training/Certification

Field

Proper training of field personnel represents a critical aspect of quality control. Details of staff training are presented in SOP 2. Safety issues related to water quality work are presented in SOP 2; all field staff will be well-versed in this SOP.

NPS staff downloading continuous loggers and collecting all other water quality data have either already been trained by other NPS staff or will be trained before plan implementation. Scientists at PORE and GOGA have been conducting water quality related activities for several years and can provide training if necessary to network staff. However, the water quality specialist is expected to be independent and knowledgeable in chemistry and water sampling techniques.

All technical staff involved in data collection will have educational background in biological or physical sciences. The network water quality specialist will have specialized experience in water quality or closely related aquatic resource. Where necessary (e.g., with staff turnover, adoption of new methods, etc.) local technical experts (universities/agencies) will be called upon for training assistance. Familiarity with GPS navigation will also be a qualification (or training will be provided). First Aid and CPR training are highly recommended. Boater certification will not be needed at this time. Field personnel will receive training in a variety of discharge (flow) measurement methods (e.g., low flow, high flow bridge-deployed).

Field personnel will be evaluated on their field performance during field QA audits conducted by the SFAN Water Quality Specialist and other park aquatic professionals. Field performance audits are recommended every two years, or more often if necessary. If any deficiencies within a crew are noted during this QA audit, they will be documented and remedied prior to continued field sampling. This can be accomplished by additional training or by changing personnel, but verification of correction of any deficiencies must be documented in writing prior to the resumption of further sample collection activities.

Laboratory
Meetings, whether by phone or in person, will be held with the laboratory(ies) at regular intervals to review QA/QC procedures and make recommendations for future revisions to the SFAN QAPP. The more frequent the interactions with laboratory staff the better the understanding of any key issues or correction of problems will be. Issues such as timing of sample transport and analysis and lab capability and capacity for samples are important to QA/QC data completeness objectives.

Section A9. Documentation and Records

- All field data gathered will be recorded on standardized field data entry forms that include metadata to be entered into the NPSTORET database.
- Data will be scanned upon receipt from laboratory and during and immediately after field measurements (this is also true of data from data loggers such as turbidity sensor, pressure transducer, or multiparameter mini-sonde data).
- Data will be more thoroughly reviewed within a week after each sampling event for inconsistencies related to field personnel, how well SOPs are followed, and how timing and logistics of sample collection and transport to laboratories may be affecting sample data.
- Field data will not be entered into the database until laboratory results have arrived.
- Field and laboratory data sheets will be copied and stored in a "data to be entered" folder.
- Original copies of datasheets and laboratory chain of custody forms will be stored in the SFAN Water Quality Monitoring Program Office in the Marin Headlands (GOGA).
- SFAN data managers will work with the SFAN hydrologic technician to ensure that data is well-understood and entered into the proper fields in NPSTORET.
- Data will be entered into the SFAN NPSTORET database no less than once a month to ensure adequate interpretation of field notes and receipt of proper laboratory QA/QC information. Each datasheet will be initialled and dated by the person entering the data.
- A different individual than the one that entered the data will verify the datasheet information against the database.
- Data will also be validated; during this process questionable data are identified, reviewed, and corrected if necessary.
- After data entry, verification, and validation, copies will be retained by the person entering the data for one year. After that time or another appropriate time, data will be archived.

Sample datasheets are included in the Appendix A of this document. Chain of custody forms vary depending upon the laboratory. Reporting of results including summary charts and reports are explained in more detail in the Water Quality Protocol Narrative.

DATA GENERATION AND ACQUISITION

Section B1. Sampling Process Design (Experimental Design)

Key to Table 7

- Core parameters*: dissolved oxygen (D.O.), specific conductance, pH, and temperature
- Flow
- Water Level*
- FIB (fecal indicator bacteria): Fecal/Total Coliforms, *E. coli*,
- Nutrients: Total nitrogen, ammonia, nitrate/nitrite,
- Sediment: Turbidity and total suspended solids (TSS) or suspended sediment concentration

Notes on Table 7

- Maps of these water bodies are located in Appendix F.
- Core parameters will be monitored continuously at sites on a rotating basis. Water level is monitored continously at sites where automatic recording stream gauges are located.
- For streams that will be sampled during a storm event, the same general storm event will be monitored every year (i.e., first flush, mid, or late-season storm; 3rd storm event, etc.)

Table 7. Target streams, parameters, and protocols to be monitored

Stream	Park	Parameters	Frequency	Personnel	Protocols
Olema Creek	PORE	Core parameters, flow, FIB, nutrients, sediment, water level	Monthly; weekly for 5 weeks in summer and winter, continuous at one site; one storm event	SFAN Water Quality Specialist	National Field Manual (USGS, various dates); Rantz , 1982 ; Peck et al., 2001; APHA et al., 1992; State Water Resources Control Board (Puckett 2002); U.S. Forest Service, 2002.
Lagunitas Creek tributaries	PORE GOGA	Core parameters, flow, FIB, nutrients, sediment	Monthly, plus one storm event	SFAN Water Quality Specialist	National Field Manual (USGS, various dates); Rantz , 1982 ; Peck et al., 2001; APHA et al., 1992; State Water Resources Control Board (Puckett 2002); U.S. Forest Service, 2002.
Pine Gulch	PORE	Core parameters, flow, water level, FIB, nutrients	Monthly	SFAN Water Quality Specialist	National Field Manual (USGS, various dates); Rantz, 1982 ; Peck et al., 2001; APHA et al., 1992; State Water Resources Control Board (Puckett 2002)
Lower Redwood Creek	GOGA MUWO	Core parameters, flow, FIB, nutrients, sediment, water level	Monthly plus one storm event; one site continuous	SFAN Water Quality Specialist	National Field Manual (USGS, various dates); Rantz, 1982 ; Peck et al., 2001; APHA et al., 1992; State Water Resources Control Board (Puckett 2002)

Table 7. Target streams, parameters, and protocols to be monitored

Stream	Park	Parameters	Frequency	Personnel	Protocols
Upper Redwood Creek	GOGA MUWO	Core parameters, flow, FIB, nutrients, sediment	Monthly plus one storm event	SFAN Water Quality Specialist	National Field Manual (USGS, various dates); Rantz, 1982 ; Peck et al, 2001; APHA et al., 1992; State Water Resources Control Board (Puckett, 2002)
Rodeo Creek	GOGA	Core parameters, flow, FIB, nutrients, sediment	Monthly plus one storm event	SFAN Water Quality Specialist	National Field Manual (USGS, various dates); Rantz, 1982 ; Peck et al., 2001; APHA et al., 1992; State Water Resources Control Board (Puckett 2002)
Tennessee Creek (GOGA)	GOGA	Core parameters, flow, FIB, nutrients	Monthly plus one storm event	SFAN Water Quality Specialist	National Field Manual (USGS, various dates); Rantz, 1982 ; Peck et al., 2001; APHA et al., 1992; State Water Resources Control Board (Puckett 2002)
Nyhan Creek	GOGA	Core parameters, flow, FIB, nutrients	Monthly	SFAN Water Quality Specialist	National Field Manual (USGS, various dates); Rantz , 1982 ; Peck et al, 2001, APHA et al., 1992; State Water Resources Control Board (Puckett, 2002)
Oakwood Creek	GOGA	Core parameters, flow, FIB, nutrients	Monthly	SFAN Water Quality Specialist	National Field Manual (USGS, various dates); Rantz , 1982 ; Peck et al, 2001; APHA et al., 1992; State Water Resources Control Board (Puckett, 2002)
West Union Creek	GOGA	Core parameters, flow, FIB, nutrients, sediment	Monthly during winter and spring	SFAN Water Quality Specialist	National Field Manual (USGS, various dates); Rantz , 1982 ; Peck et al, 2001; APHA et al., 1992; State Water Resources Control Board (Puckett 2002); U.S. Forest Service, 2002.
Franklin Creek	JOMU	Core parameters, flow, water level, FIB, nutrients	Monthly	SFAN Water Quality Specialist; assistance from local volunteers	National Field Manual (USGS, various dates); Rantz, 1982 ; Peck et al, 2001, APHA et al., 1992; State Water Resources Control Board (Puckett 2002)
Strentzel Creek	JOMU	Core parameters, flow, sediment	Storm events	SFAN Water Quality Specialist; assistance from local volunteers	National Field Manual (USGS, various dates); Rantz, 1982 ; APHA et al., 1992; State Water Resources Control Board (Puckett 2002); U.S. Forest Service, 2002.
Chalone Creek	PINN	Core parameters, flow, FIB, nutrients, sediment	Monthly during winter and spring; one storm event	SFAN Water Quality Specialist with park staff assistance as available	National Field Manual (USGS, various dates); Rantz, 1982 ; Peck et al., 2001; APHA et al., 1992; State Water Resources Control Board (Puckett 2002)

B2. Sampling Methods

All measurements and sampling associated with monitoring activities will be conducted according to the SOPs outlined in the protocol narrative. If there is a change in the protocol such as a change in sampling method, equipment, or staff, then there will be overlap of methods and personnel where possible (see SOP 1: Methods for Protocol Revision).

Section B3. Sample Handling and Custody Requirements

Proper sample handling procedures for water, sediment, and biological samples are provided in Table 8. This table provides a summary of recommended sample containers, sample volumes, initial preservation, and maximum storage times for water samples. In the field, all samples will be packed in frozen ice packs during shipment, so that they will be kept at approximately 4˚C. Samples will be shipped in insulated containers. All caps and lids will be checked for tightness prior to shipping. All samples will be handled, prepared, transported and stored in a manner so as to minimize bulk loss, analyte loss, contamination or biological degradation. Sample containers will be clearly labeled with an indelible marker. Where appropriate, samples may be frozen to prevent biological degradation. Water samples will be kept in glass or plastic bottles and kept cool at a temperature of 4˚C until analyzed.

Table 8. Summary of Sample Handling Requirements

Analyte	Sample Container	Minimum Sample Volume/Typical Sample Volume	Holding Time	Preservation
Total Kjeldahl Nitrogen (TKN)	Plastic bottle	600 mL	Recommend: 7 days; Maximum: 28 days	Cool to 4°C
Nitrate and Nitrite	Plastic bottle	125 mL/150 mL	48 hours	Cool to 4°C
Ammonia	Plastic bottle	125 mL/500 mL	48 hours 28 days with preservative	Sulfuric acid preservative, Cool to 4°C
Fecal & Total Coliform	125 ml sterile plastic (high density polyethylene or polypropylene) container	100 ml volume sufficient for both fecal and total coliform analyses	6 hours at 4°C, dark for regulatory data use;lab must be notified well in advance. Possibly 24hr hold time at 4C dark, if non-regulatory data use.	Sodium thiosulfate is pre-added to the containers in the laboratory (chlorine elimination). Cool to 4°C; dark.
Suspended Sediment Concentration (SSC) or Total Suspended Solids (TSS)	500 ml clean plastic bottle	500 ml (one bottle)	7 days	Cool to 4°C
Turbidity	glass vial	15 mL	NA	NA

Laboratory Custody Log

Laboratories chosen will be National Environmental Laboratory Accreditation Program (NELAP) certified and this is discussed further in the protocol narrative. Therefore, they are expected to follow standard procedures. Laboratories will maintain custody logs sufficient to track each sample submitted and to analyze or preserve each sample within specified holding times.

Field Log

The following items will be recorded on data sheets for each sampling station:

- Time of sample collection;
- Sample ID numbers,
- The results of any field measurements (temperature, D.O., pH, conductivity, turbidity) and the time that measurements were made;
- Qualitative descriptions of relevant water conditions (e.g. color, flow level, clarity) or weather (e.g. wind, rain) at the time of sample collection;
- A description of any unusual occurrences associated with the sampling event, particularly those that may affect sample or data quality.

Field personnel will have custody of samples during field sampling. Chain of custody forms will accompany all samples during transport/shipment to the contract laboratories. Field personnel will enter sampling time and other relevant data on the chain of custody forms. All water quality samples will be transported to the analytical laboratory directly by the field crew or by overnight courier. See Appendix A for field data sheets. Chain of custody forms vary depending on the laboratory.

Section B4. Analytical Methods Requirements

Detection limits may be affected by instrument sensitivity or by bias due to contamination or matrix interferences. Common laboratory practice is to adjust detection limits upward in cases where high instrument precision (i.e., low variability) results in calculated detection limits that are lower than the absolute sensitivity of the analytical instrument. In these cases, best professional judgment is used to adjust detection limits upward to reduce false positives and values below the detection limit are not reported. In all cases, results cannot be reported for values less than the Method Detection Limit (MDL). Most MDLs are considerably lower than water quality objectives and provide the foundation for having a high level of certainty in the data (Puckett, 2002).

Data below or beyond an MDL will not be presented numerically. Data falling between the MDL and minimum level of quantitation (ML) are considered “semi-quantitative” and can be presented as greater than zero. They are detected but not quantifiable and can be given a flag of DNQ (detected, not quantifiable). The ML is equal to the MDL multiplied by five (or some number between 1-10 that may be determined by the analytical laboratory). Censored data can be presented as less than or greater than the ML in order to compare it to water quality criteria

(Irwin, 2004). See the section "Preparing the Raw Data Set for Analysis" in SOP #10 (data analysis)

The SFAN Water Quality Monitoring Program will follow the same guidelines as the SWAMP program for recommended use of detection and quantification limits:

- Values below the Method Detection Limit (MDL) are to be reported as a (<) sign followed by the actual MDL value, and flagged with an ND = not detected.
- Values between the MDL and the ML (or quantification limit) should be reported as the actual measured value, with a flag that is carried all the way through data storage, handling, and reporting. The flag is DNQ = detected, not quantifiable.
- Values above the ML (or quantification limit) are deemed as acceptable values without reservation, and are shown as the actual measured value, and assigned a QA code of A (acceptable without reservation).

In general, laboratories should strive to meet target reporting limit recommendations for undetected analytes. In those cases where high concentrations of some analytes require analysis of a diluted sample and the dilution results in non-detects for other analytes, analysis of the sample at several different dilutions may be required to meet program detection limits as fully as practical. Table 9 lists analytical methods and measurement quality objectives (MQOs) for all water quality parameters except flow. In addition to the MDL, these include precision, and systematic error/bias/percent recovery. Details of QA/QC for flow measurements will be outlined in a separate protocol.

Table 9. Measurement Quality Objectives

Parameter	**Instrument or Method**	**Precision (RPD of duplicates)**	[1] **Measurement Systematic Error (% recovery)**	[2]**Alternative Measurement Sensitivity (AMS)**	**Method Detection Limit**	[3] **Minimum Level of Quantitation (ML)**
pH	Oakton pH testr 3+	$\pm$ 0.1 units	95-105%	***	0.01 pH	0.0318 pH
Dissolved oxygen	YSI 85	$\pm$ 0.3 mg/L	95-105%	***	0.01mg/L	0.0318 mg/L
Salinity	YSI 85	$\pm$ 2% or $\pm$0.1 ppt		***	0.1 ppt	0.318 ppt
Temperature	YSI 85	$\pm$ 0.2 ^{0}C	95-105%	***	0.01^{0}C	0.0318 ^{0}C
Specific Conductance or Conductivity	YSI 85	$\pm$ 5 uS/cm or $\pm$ 3% of the measured value, whichever is greater	95-105%	2.5 uS/cm	0.1 uS/cm	

Table 9. Measurement Quality Objectives (continued)

Parameter	Instrument or Method	Precision (RPD of duplicates)	[1] Measurement Systematic Error (% recovery)	[2]Alternative Measurement Sensitivity (AMS)	Method[5] Detection Limit	[3] Minimum Level of Quantitation (ML)
Total Kjeldahl Nitrogen	SM 4500 EPA 300	±30%		0.5 mg/L (Puckett, 2002)	0.2 mg/L	3.18 x MDL
Nitrate as N	SM 4500 EPA 300	±30%		0.01 mg/L	0.05 mg/L	3.18 x MDL
Nitrite as N	SM 4500 EPA 300	±30%		0.01 mg/L	0.01 mg/L	3.18 x MDL
Ammonia-Nitrogen	SM 4500F	±30%		0.1 mg/L	0.05 mg/L	3.18 x MDL
Fecal coliforms[4]	SM 9221B	±60%		To be calculated	2 MPN/100mL	3.18 x MDL
Total coliforms[4]	SM 9221	±60%		To be calculated	2 MPN/100mL	3.18 x MDL
Total Suspended Solids	SM 2540D	30%		0.5 mg/L	0.5 mg/L	3.18 x MDL
Turbidity	Hach 2100 turbidity meter	±2 NTU or ±5 % of the measured value, whichever is greater (USGS) ± 2% (Hach)	90-110%	0.5 NTU (Puckett, 2002)	0.01 NTU	3.18 x MDL

[1] Often referred to as accuracy

[2] Formerly referred to as the Reporting Detection Limit; AMS is the measurement precision uncertainty based on a sample size of seven environmental samples (not blank) and 99% confidence (Irwin, 2004). This should be calculated at the beginning of the field season, during the winter (high flow) and at the end of the field season.

[3] Formerly referred to as Practical Quantitation Limit (PQL) and the Limit of Quantification (LOQ) in the SWAMP QAMP (Puckett, 2002). The ML is generally the MDL multiplied by a number between 3.18. See: http://www.epa.gov/waterscience/methods/det/rad/rad.pdf

[4] The bacteria detection limit is 2-1600 (20-16,000, etc. if dilutions are needed). This detection limit is consistent with the California Regional Water Quality Control Board's Surface water Ambient Monitoring Program (Puckett, 2002).

[5] MDLs for nutrients are those recommended by the San Francisco Bay Regional Water Quality Control Board (Peter Krottje, personal communication, June 2005).

Citations for MQOs:

- Precision obtained from USGS (Wagner et al., 2000) and YSI 85, Oakton, and Hach manuals
- Measurement Systematic error, % recovery numbers obtained from
- MDLs obtained from SWAMP QAMP (Puckett, 2002), Crissy Field Restoration QAPP Ward, 2004), and the YSI 85 Manual

- Use EPA's EMAP http://www.epa.gov/emap/nca/html/docs/c2k_qapp.pdf
- PQLs are calculated

Section B5. Quality Control Requirements

Laboratory Quality Control Requirements

There is a broad range in the quality of waters within SFAN. For more pristine waters (those in wilderness areas), it is critical that laboratories be able to provide low-level detection of pollutants. Some of the approaches required will include laboratory matrix spikes, laboratory method blanks, calibration standards, laboratory- and field-duplicated samples, and others as appropriate. The definition and use of each of these types of quality control samples are explained further below (Puckett, 2002).

Laboratories providing analytical support for chemical or biological analyses will have the appropriate facilities to store, prepare, and process samples, and appropriate instrumentation and staff to provide data of the required quality within the time period dictated by the project (Puckett, 2002).

Laboratories will be able to provide information documenting their ability to conduct the analyses with the required level of data quality. Such information might include results from interlaboratory calibration studies, control charts and summary data of internal QA/QC checks, and results from certified reference material analyses (Puckett, 2002). Laboratories should provide a laboratory QA plan, SOPs, Analytical Methods Manual, Instrument Performance Information, and Control Charts.

Measurement Quality Objectives (MQOs)

Some MQOs and quality control checks are defined below (*from* Puckett, 2002):

Completeness

Data completeness is the amount of data collected compared against the expected amount.

Precision criteria: Precision is the reproducibility of an analytical method. Each laboratory is expected to maintain control charts for use by analysts in monitoring the overall precision of the CRM (Certified Reference Materials) or LCM. Upper and lower control chart limits (e.g., warning limits and control limits) will be continually updated; control limits based on 99% confidence intervals around the mean are recommended. The relative standard deviation (RSD) will be calculated for each analyte of interest in the CRM based on the last 7 CRM analyses.

Laboratory Replicates for Precision

A minimum of one field sample per set of SFAN water samples submitted to the laboratory will be processed and analyzed in duplicate to determine precision. The relative percent difference among duplicate samples (RPD expressed as percent) will be less than the MQO's in Table 9.

Each measured value is compared against the known value of the standard, and accuracy is expressed as the relative percent difference.

$$\mathrm{RSD} = \frac{[V_m - V_k]}{V_k}$$

Where: RSD = the relative standard deviation
Vm = the measured value,
Vk = the known value.

Relative percent difference (RPD) is the RSD x 100%.

A laboratory control spike (LCS) and duplicate (LCSd) will be analyzed to determine percent recovery of each specific method. In addition, the State of California ELAP requires that 1 in 20 samples have a CMS, or client matrix spike. Therefore, in addition to the laboratory spikes, the client's samples are also spiked. However, CMS' are not conducted for bacteria samples (Mark Valentini, personal communication, December 2004).

Laboratory Method Blank

Laboratory method blanks (also called extraction blanks, procedural blanks, or preparation blanks) are used to assess laboratory contamination during all stages of sample preparation and analysis.

Surrogates

Surrogates are compounds chosen to simulate the analytes of interest in organic analyses. Surrogates are used to estimate analyte losses during the extraction and clean-up process and must be added to each sample, including QA/QC samples, prior to extraction.

Matrix Spike and Matrix Spike Duplicate

A laboratory fortified sample matrix (commonly called a matrix spike, or MS) and a laboratory fortified sample matrix duplicate (commonly called a matrix spike duplicate, or MSD) will be used both to evaluate the effect of the sample matrix on the recovery of the compound(s) of interest and to provide an estimate of analytical precision. Recovery is the accuracy of an analytical test measured against a known analyte addition to a sample.

Travel Blanks - The purpose of the travel blank is to determine if there is any cross-contamination of volatile constituents between sample containers. Travel blanks are not required for other analytes, but are encouraged to be utilized for other analytes as possible and appropriate.

Equipment Blanks (done in lab prior to field work) - To insure that equipment used during sampling does not contaminate samples, the device is filled with DI water or DI water is pumped through the device, transferred to sample bottle(s), preserved (if appropriate) and analyzed by the lab. Equipment blanks are run when new equipment, equipment that has been cleaned after use at a contaminated site, or equipment that is not dedicated for surface water sampling, is used.

Field Duplicates - Duplicate samples will be collected for all parameters at an annual rate of 5% of total samples to be collected within a given year's monitoring plan. The duplicate sample will be collected in the same manner and as close in time as possible to the original sample. This effort is to attempt to examine field homogeneity as well as sample handling, within the limits and constraints of the situation. The precision for determining precision of field duplicates is described in SOP #10- Data Analysis.

Field Blanks - A field blank is designed to assess potential sample contamination levels that could occur during field sampling and sample processing. Field Blanks (DI water) are taken to the field, transferred to the appropriate container, preserved (if appropriate), and otherwise treated the same as the corresponding sample type during the course of a sampling event. Field blanks are to be collected at a 5% rate for the following nutrient and bacteria samples. Field blanks for other analytes should be conducted upon initiation of sampling, and if field blank performance is acceptable, further collection and analysis of field blanks for these other media and analytes need only be performed on an as-needed basis, or during field performance audits.

Copies of laboratory QA/QC work will be included with analytical results and kept on file

Table 10. QA protocols

Measurement Parameter	**QA Protocol**
pH	Equipment blanks
Dissolved oxygen	Equipment blanks
Temperature	Equipment blanks
Specific Conductance	Equipment blanks
*Total Kjeldahl Nitrogen	Duplicates 10% of samples, lab matrix spike
*Nitrate as N	Duplicates 10% of samples, lab matrix spike, Field Blank, Trip Blank
*Nitrite as N	Duplicates 10% of samples, lab matrix spike, Field Blank, Trip Blank
*Nitrate + Nitrite	Duplicates 10% of samples, lab matrix spike, Field Blank, Trip Blank
*Ammonia	Duplicates 10% of samples, lab matrix spike, Field Blank, Trip Blank
*Fecal coliforms	Lab and field duplicates, Field Blank, Trip Blank
*Total coliforms	Lab and field duplicates, Field Blank, Trip Blank
*Total Suspended Solids	Lab and field duplicates, Field Blank, Trip Blank
Turbidity	Equipment blanks

*Also refer to laboratory QA manuals for lab parameters

Section B6. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

To minimize or avoid downtime of measurement instruments, all field sampling and laboratory equipment will be maintained in good working order. Also, spare equipment or common spare parts (e.g., batteries, D.O. membranes, pH electrodes) will be available so that repairs or replacement can be made as quickly as possible and measurements will not be lost. All field equipment having manufacturer-recommended schedules of maintenance will receive preventive maintenance according to that schedule (see Table 11). Other equipment used only occasionally will be inspected at least monthly. After use in the field, all equipment will be re-checked for needed maintenance.

Section B7. Instrument Calibration and Frequency

An instrument or device used in obtaining an environmental measurement must be calibrated by the measurement of a standard. Every instrument or device has a specialized procedure for calibration and a special type of standard used to verify calibration. See instrument manuals for further details. A log book will be kept to record dates of calibration and any equipment errors or failures, battery changes, changes of calibration solutions, and repair notes. The log book will also contain calibration methods, this schedule of inspections and calibrations, and a list of needed supplies and equipment. When a change in equipment occurs, overlapping measurements will be made using both the old and new equipment in order to document precision in reproducibility.

Table 11. Routine Instrument Inspections and Calibrations

Parameter	Calibration Frequency	Acceptance Criteria	Corrective Actions
Temperature Liquid-in-glass thermometer:	Every 3 to 6 months, using a 2-point calibration, and annually, using a 3-point calibration 10% of the readings taken each day must be duplicated, or a minimum of 1 reading if fewer than 10 samples are read.	±1.0 °C	Re-test with a different thermometer; repeat measurement
Temperature Thermistor thermometer:	Every 3 to 4 months, check calibration, annually, using a 5-point calibration	Same as above	Re-test with a different thermometer; repeat measurement
Specific Conductance	Prior to field mobilization, at the field site, and calibration check at day's end; 10% of the readings taken each day must be duplicated or a minimum of 1 reading if fewer than 10 samples are read.	±5%	Re-test; check low battery indicator; use a different meter; use different standards; repeat measurement

Table 11. Routine Instrument Inspections and Calibrations (continued)

Parameter	Calibration Frequency	Acceptance Criteria	Corrective Actions
Dissolved oxygen	Prior to field mobilization, at the field site, and calibration check at day's end	±10%	Re-enter altitude; re-test; check low battery indicator; check membrane for wrinkles, tears or air bubbles; replace membrane; use a different meter; repeat measurement
Hydrolab ® minisonde datalogger	Beginning and end of each deployment	See manual	
pH meter	Prior to field mobilization (three point calibration using buffer solutions (pH 4,7, and 10)) At the field site, and calibration check at day's end (one point calibration) 10% of all reading taken each day must be duplicated or a minimum of 1 reading if fewer than 10 samples are read.	±0.05 pH unit; ±0.1 pH unit RPD ±0.1 pH unit	Re-test; check low battery indicator; use different standards; repeat measurement
Flow meter (velocity meter)	Prior to field mobilization, before each sampling run; some flow meters required and annual calibration by the manufacturer		

-All instrument should be visually inspected before use
-Check batteries before use
-Rinse all equipment after use
-Insure that pH electrodes and D.O. membrane remain moist

Section B8. Inspection/Acceptance Requirements For Supplies And Consumables

Not Applicable.

Section B9. Data Acquisition Requirements (Non-direct Measurements)

Water quality monitoring data from sources other than this WRD-funded monitoring plan will not be entered directly into the SFAN version of NPSTORET. However, other monitoring entities will be encouraged to collect appropriate metadata so that their data can be used by other entities and most likely by this program. Other groups will be encouraged to upload their data to the National version of STORET. SFAN can then use this data if it can be used to help answer monitoring questions for existing sites or will help fill in data gaps that this program cannot cover. In addition, other data collected by SFAN monitoring programs (e.g., weather and stream hydrology data) will be utilized in conjunction with the water quality data.

Section B10. Data Management

A general overview has been provided in sections A6 (Project /Task Description) and A9 (Documents and Records). Data management is covered in detail in the SFAN Freshwater Quality Protocol Narrative including database structure and metadata requirements. SFAN personnel will work closely with WRD regarding use of, and modifications to the NPSTORET database.

ASSESSMENT AND OVERSIGHT

Section C1. Assessments and Response Actions

Field staff will sometimes be required to work independently, though ideally there will be two individuals in the field. Having two individuals not only is a safety measure, but can also serve as a quality control measure. In most cases, the primary individual conducting monitoring will be the SFAN Water Quality Specialist who has the dual role of Project Leader and Quality Assurance Manager. Additional field assistants may be park or SFAN staff or volunteers as available. If problems in field sampling arise, the water quality specialist will determine whether sampling should be re-scheduled or sampling equipment/methods modified. Records will be kept of all quality control issues and corrective actions.

If site conditions or method improvements/modifications require protocol revision, the Project Leader will discuss these changes with field crew and document protocol revision (see SOP 10: Methods for Protocol Revision). If major changes are warranted, the SFAN Aquatic Professionals group will meet to discuss recommended changes. Final revisions to the QAPP will be approved by the SFAN Aquatic Professionals Group and WRD. If necessary, a group of local technical experts (the same group, if possible, as the external peer review team) will meet to discuss methods issues.

Section C2. Reports to Management

Annual summary reports will be provided to WRD and to individual parks by October 30 of each year. Additionally, comprehensive reports will be created every three to five years for more detailed analysis including trends. These reports will include data from 2-4 years since watersheds are monitored on a two-year rotating basis. These comprehensive reports will be provided to WRD and to the individual parks with data analysis customized for the individual parks. The comprehensive reports will include a Quality Assurance Report explaining the results of data completeness and other QA/QC issues.

DATA VALIDATION AND USABILITY

Section D1. Data Review, Validation, and Validation Requirements

The EPA has recently provided a comprehensive guidance document (EPA 2001), entitled *Guidance on Environmental Data Verification and Data Validation (EPA QA/G-8).* The purpose of this guidance is to explain how to implement data verification and data validation, and to provide practical advice and references. Although data verification and data validation are commonly-used terms, they are defined and applied differently in various organizations and quality systems. The Surface Water Ambient Monitoring Program (SWAMP)follows EPA's informal guidance on this topic, as provided in EPA 2001, and incorporates the following definitions (*from* Puckett, 2002):

Data Verification is confirmation that what has been entered into the database is what is actually on the datasheets. Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements (Puckett, 2002).

Data Validation is an "analyte-and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set" (Puckett, 2002). In other words, data validation is the final step in assuring the accuracy of data transfer from raw to digital form. Questionable data are identified, reviewed, and corrected if necessary. Automatic validation that checks the data as it is entered will also occur. These automatic validations are programming elements that "censor" the data based on known ranges. Therefore the data manager would not be allowed to enter data that is invalid or nonsense such as 16 for pH or a date in the future. Through this process, outliers are identified. Examples of common errors are missed decimal places, numerical data placed in the wrong field (for example, the database shows a pH of 12 when 12 is actually the water temperature). Outliers can be identified through simply graphing all observations for a given station and parameter or graphing all station data together if there is only low to medium variability.

Section D2. Validation and Verification Methods

All data reported for the SFAN Water Quality Monitoring Program will be subject to checks for errors in transcription, calculation, and computer input. Field data are initially validated by data graphing and recognition of outliers needing verification. These checks are described in the protocol narrative and in section A9.

All laboratory data forms must be accurate and complete. Any changes to the data forms will be noted, initialed and dated on the form. Any actions taken as a result of the data review will also be noted on the data sheet (Puckett, 2002).

Section D3. Reconciliation with Data Quality Objectives

Any data that do not meet DQO will not be used. If data quality issues arise, a determination will be made on whether the error was caused by equipment failure or operator error. If additional staff training, equipment repair, or minor revisions to the protocol or SOPs do not correct the problem, then the DQOs will be re-evaluated for feasibility of attainment. If they are determined to be unattainable, then they will be modified or the use of the parameter(s) in question will be evaluated. In some cases, a parameter may be eliminated if no reasonable/acceptable DQOs can be attained (Ward, 2004).

LIST OF ACRONYMS

CMS	Client Matrix Spike
COC	Chain of Custody
CWA	Clean Water Act
DFG	Department of Fish and Game
DHS	Department of Health Services
DQO	Data Quality Objective
DWR	Department of Water Resources
ELAP	Environmental Laboratory Accreditation Program
EMAP	Environmental Monitoring and Assessment Program (EPA's)
LCS	Laboratory Control Spike
MDL	Method Detection Limit
PQL	Practical Quantitation Limit
QAMP	Quality Assurance Management Plan
QAPP	Quality Assurance Project
QA/QC	Quality Assurance/Quality Control
RDL	Reporting Detection Limit
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
RWQCB	Regional Water Quality Control Board
SFEI	San Francisco Estuary Institute
SOP	Standard Operating Procedure
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
UC	University of California
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

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APPENDIX A

SFAN Water Quality Monitoring Program Field Data Sheet

Station ID ____________________
Site Location ____
Date ___________
Time ___________PST
Field Crew ______________________

Parameter	*Measurement	Units	**Value Type	Instrument	Detection Limit
Temperature					
Conductivity					
Specific Conductance					
Salinity					
Dissolved Oxygen		%			
Dissolved Oxygen		mg/L			
pH					
Flow					

* Take seven measurements at the beginning of each quarter (Oct., Jan., April, July) to obtain standard deviation for calculating PQL
** Actual, Calculated, Estimated

Field Conditions

____
____

Notes

____
____
____

Storm event? _____ If so, which storm of the season (1st, 4th, 7th)? _______________

SFAN Water Quality Monitoring Program Field Data Sheet For Flow Measurements

Station ID ____________________
Site Location ____
Date ____________Time ____________PST
Field Crew ______________________
Field Conditions ____

Station (ft)	Depth (ft)	Velocity (ft/s)	Average V	Cumulative Q
REW:				
LEW:				

V – velocity Q – discharge

Begin Time:_____________
End Time: _____________
Gauge height: ___________

Number of days since last significant rainfall___________

Notes from USGS Flow Measurement Methods:

- For shallow depths, use 6/10 method
- For deep depths (> 1.5 ft) use the 2/10 and 8/10 method
  - To get 2/10 depth multiply 6/10 depth by 2
  - To get 8/10 depth divide 6/10 depth by 2
- Space the verticals so that no sub-section has more than 10% (ideally 5%) of the discharge
- There should be 20-30 sub-sections
- Keep the first sub-section as small as possible (depth will often be zero and assume no flow)
- Parts of the stream cross-sections with greater depth and velocity should have closer verticals
- Face the bank while taking measurement (stand beside not behind wading rod)
- Position yourself at least 18' from the wading rode
- Measure velocity for at least 40 seconds
- Check the meter during measurement
- Have an idea what the discharge will be before measurement
- Read gauge height after measurement
- Reach should be straight and uniform; measure downstream of riffle
- Streambed should be free of large rocks, obstructions